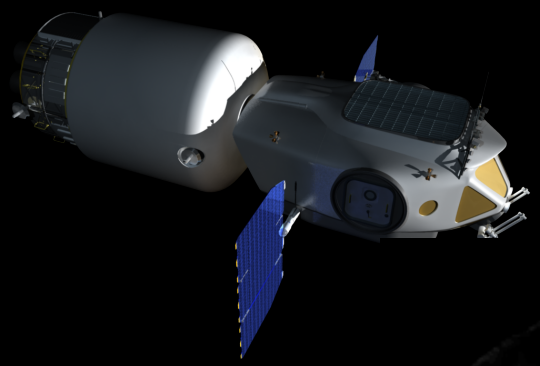
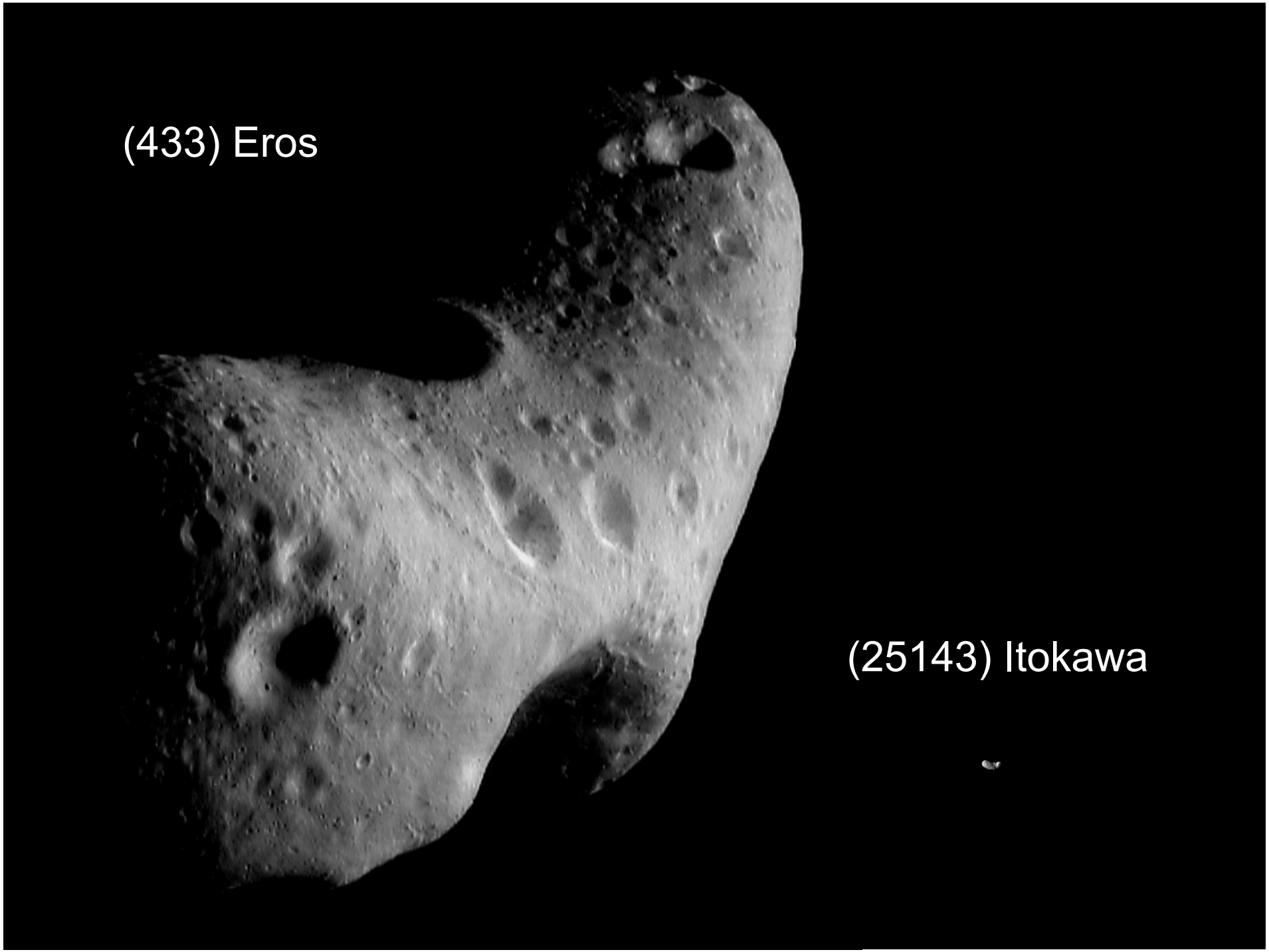
# Why Go to a NEO?
# An Astronaut's Top Five



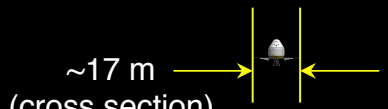
**Tom Jones**
**IHMC**

**Explore NOW**
Aug 10, 2010

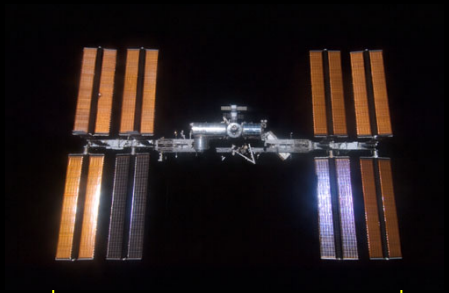

(433) Eros
(25143) Itokawa

# Asteroid Itokawa, ISS, and CEV Orion

CEV Orion




Yoshinodai



540 meters

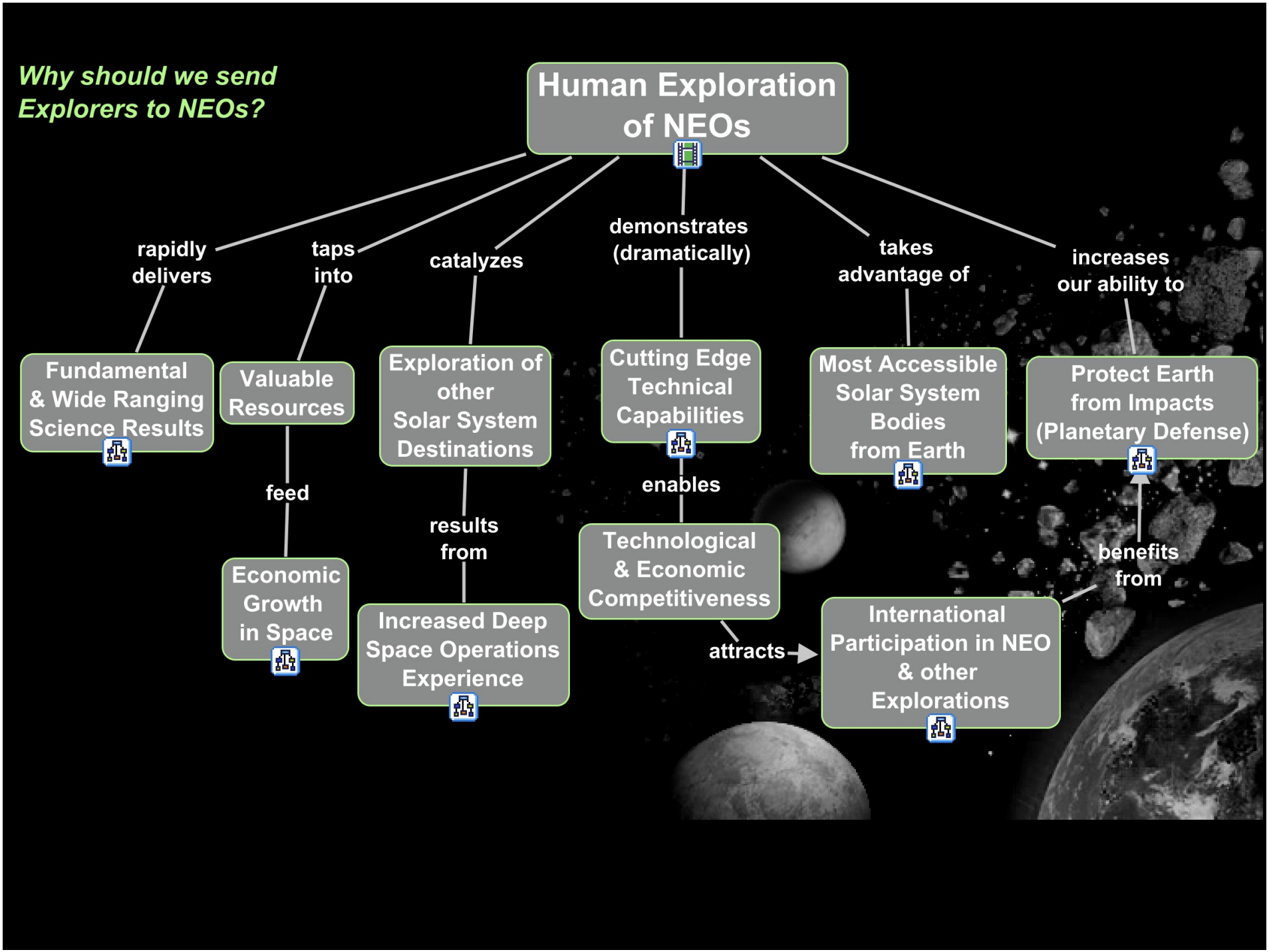
~110 meters
(ISS at 15A Stage)

JAXA, NASA

# Why Go to a NEO?

Overview

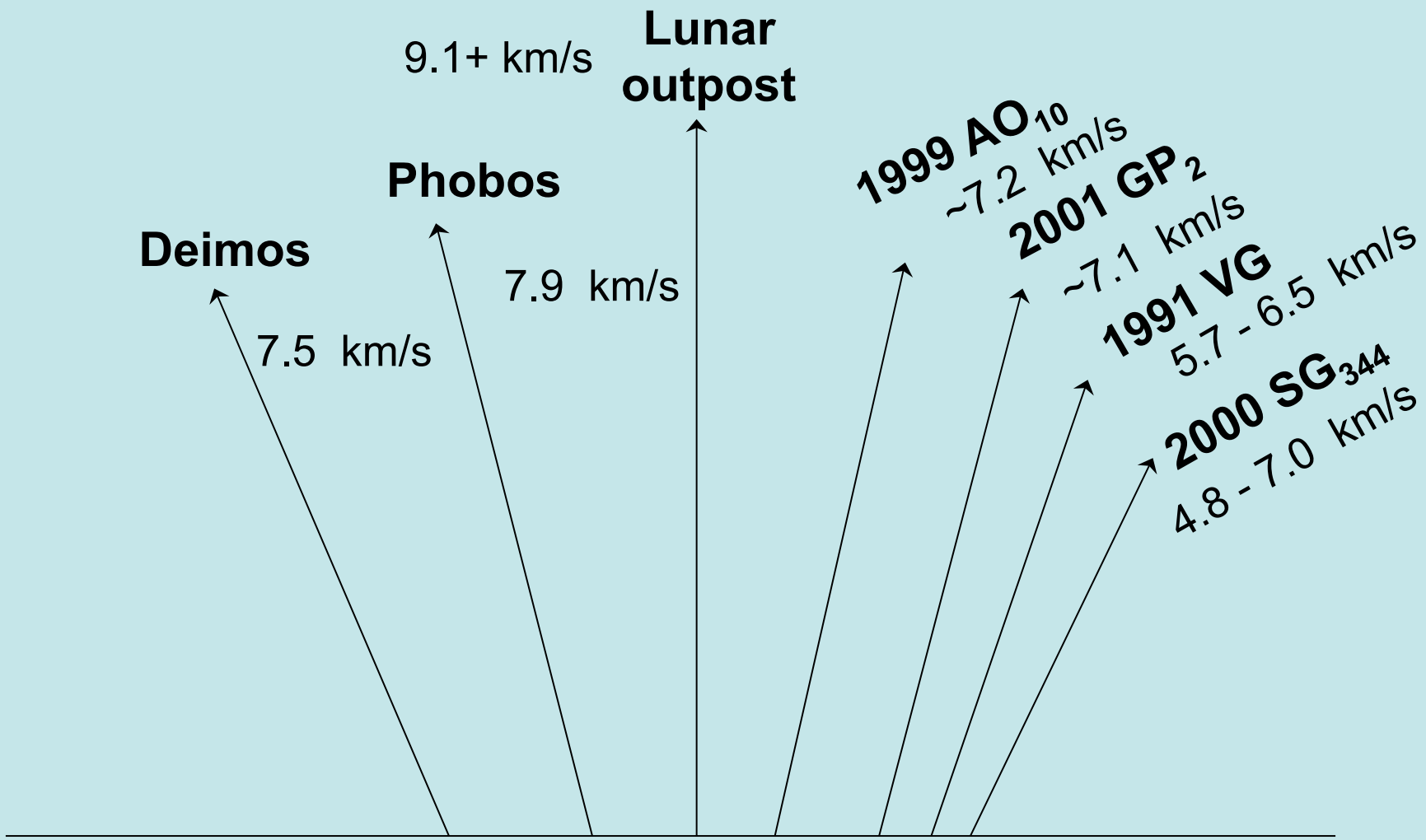
- Accessibility
- Science of our Origins
- Human Survival
- Resources for Exploration
- Stepping Stones to Mars


Why should we send Explorers to NEOs?
Human Exploration of NEOs
rapidly delivers
taps into
catalyzes
demonstrates (dramatically)
takes advantage of
increases our ability to
Fundamental & Wide Ranging Science Results
Valuable Resources
Exploration of other Solar System Destinations
Cutting Edge Technical Capabilities
Most Accessible Solar System Bodies from Earth
Protect Earth from Impacts (Planetary Defense)
feed
results from
enables
benefits from
Economic Growth in Space
Increased Deep Space Operations Experience
Technological & Economic Competitiveness
attracts
International Participation in NEO & other Explorations

# Drivers for NEO Exploration

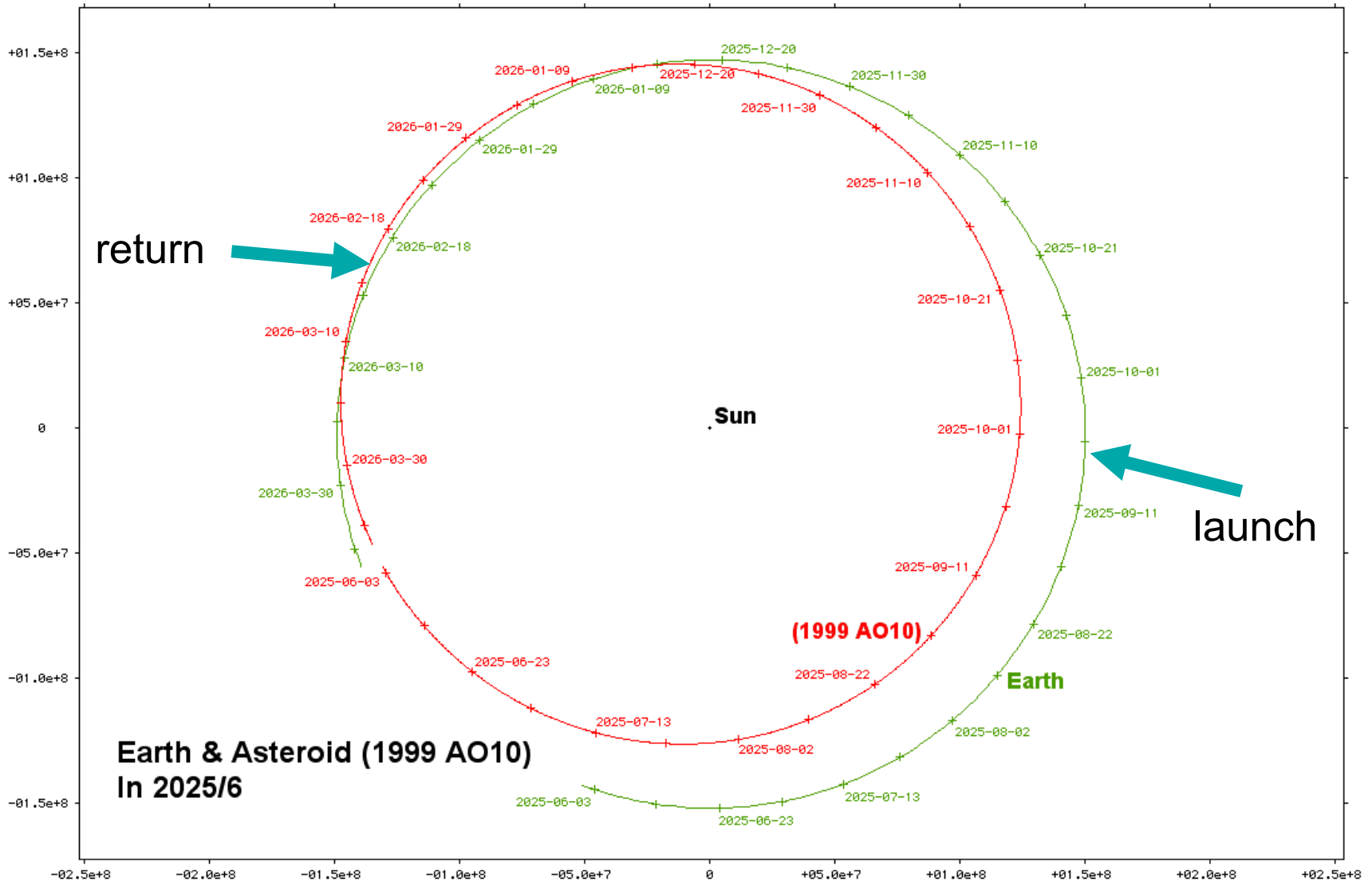
- **Accessibility**
- Science
- Resources
- Operations Experience
- Planetary Defense

# $\Delta v_{tot}$ Comparisons for Lunar Surface, Phobos, Deimos, and a few NEOs




*for NEOs $\Delta v$ depends on phasing of orbit and when mission is launched.*

# 150-Day Mission to 1999 $AO_{10}$
# Heliocentric Trajectory Plot for Mission




Km Units View From Y= 0.0°, P= 0.0°, R= 0.0°
Sun-Centered J2KE Coordinate System
Visit to (1999 AO10)

# Drivers for NEO Exploration

- Accessibility
- Science
- Resources
- Operations Experience
- Planetary Defense

# Raw Materials from Planet Formation





# Drivers for NEO Exploration

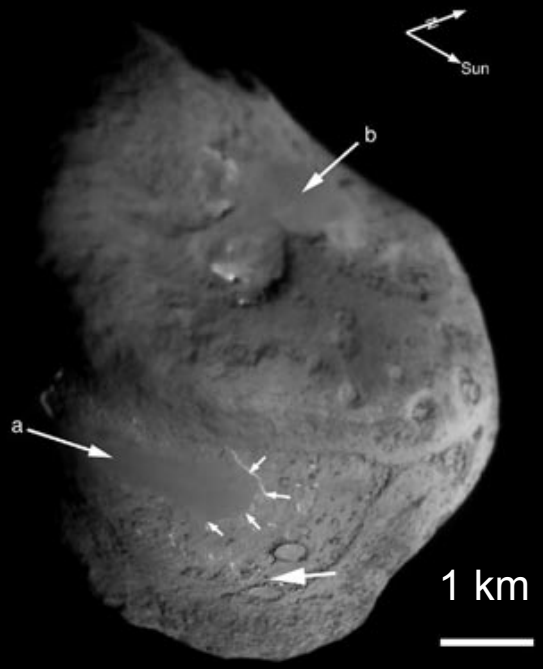
- Accessibility
- Science
- Resources
- Operations Experience
- Planetary Defense

# Water-rich Minerals

253 Mathilde from NEAR

C-type
59 x 47 km

Murchison
(12% $H_2O$)




Tempel 1
Prior to Deep Impact

# Drivers for NEO Exploration

- Accessibility
- Science
- Resources
- Operations Experience
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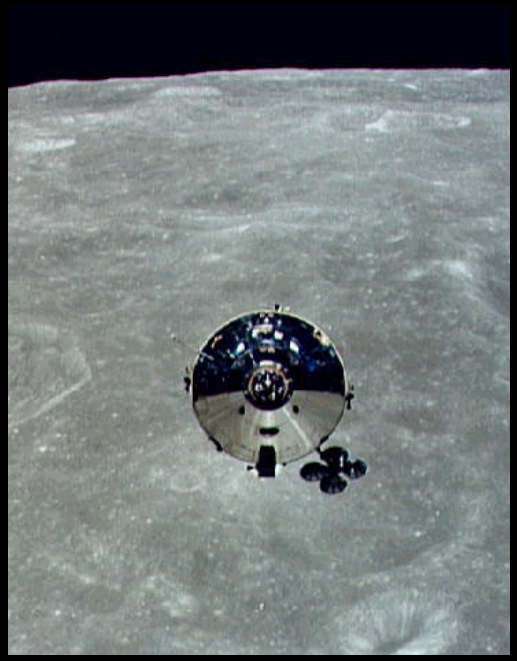
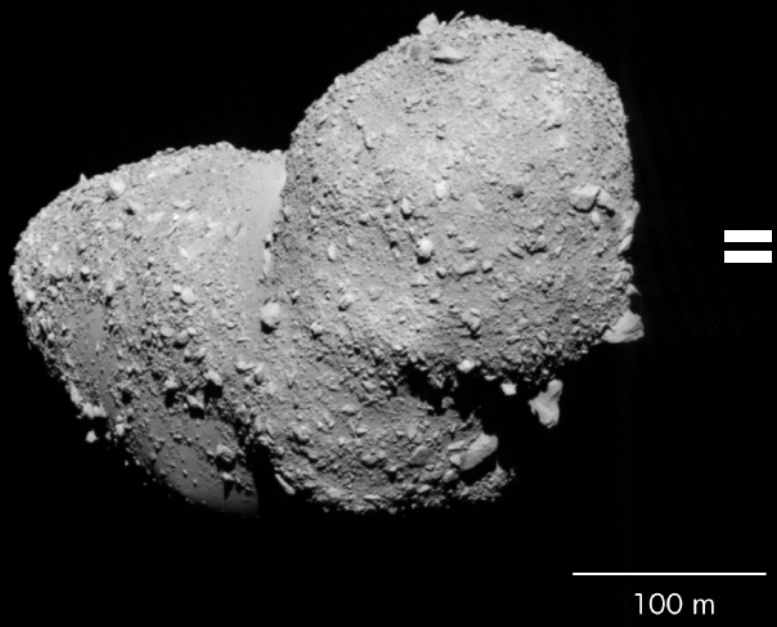
# Shakedown Cruise



- Apollo 8 and 10 (1968-69)
- Test hardware
  "close to home"
- Deep space experience
- No lander necessary

Earth-Moon from NEAR

# Extensive, challenging terrain to explore

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**Itokawa**

Vatican City
0.44 km$^2$

# Drivers for NEO Exploration

- Accessibility
- Science
- Resources
- Operations Experience
- Planetary Defense

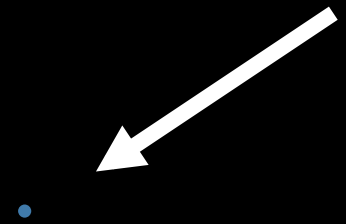
# Why Go?

## Survival

**NEO exploration acquires vital knowledge to prevent future impacts**

# Highly visible and dramatic exploration

**Earth from Apollo 16**



Earth from NEO at 0.05 AU :

**Apparent size**
**of a**
**BB held at 2.4 m**


Courtesy/ © Pat Rawlings

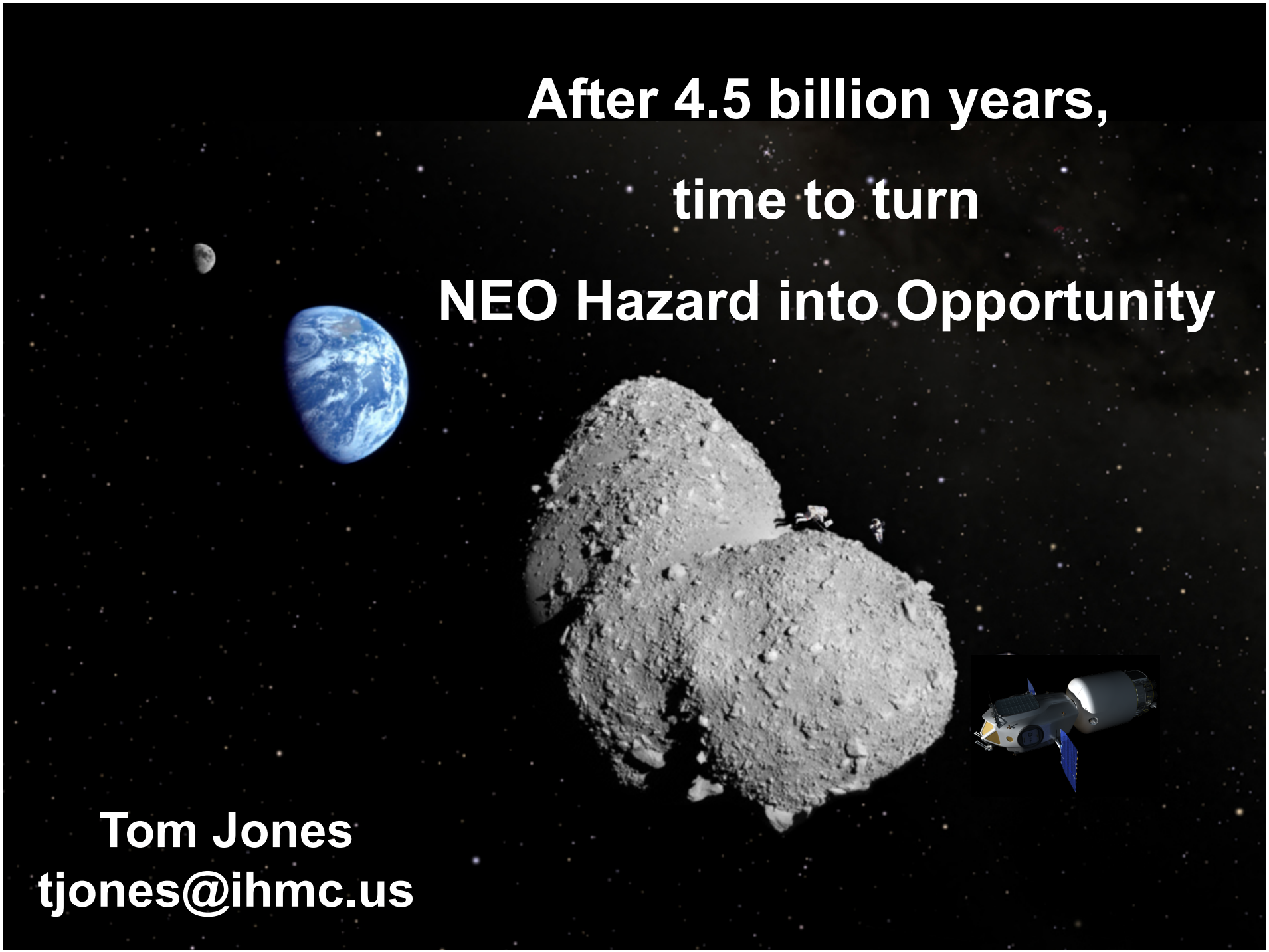
## Next Steps to NEOs

- Complete rapid NEO target survey – ID NEO tgts
- Research & development on:
  - radiation countermeasures
  - habitation and life support
  - NEO mobility systems
- ISS testing of deep-space and mobility systems
- New operations and risk reduction strategies
- Heavy lift capability

# NEOs should be NEXT

- Inviting “stepping stones” for US & Partners
- Compelling attractions:
  - Accessible with envisioned systems
  - Science – interdisciplinary – opens “3rd Planet”
  - Know-how for impact prevention
  - Resources to catalyze exploration, industry
  - Springboards to Moon, Mars, & Beyond
    - sustainable, visible steps into deep space
- NEO missions leverage astronaut skills, experience, adaptability

# After 4.5 billion years, time to turn NEO Hazard into Opportunity



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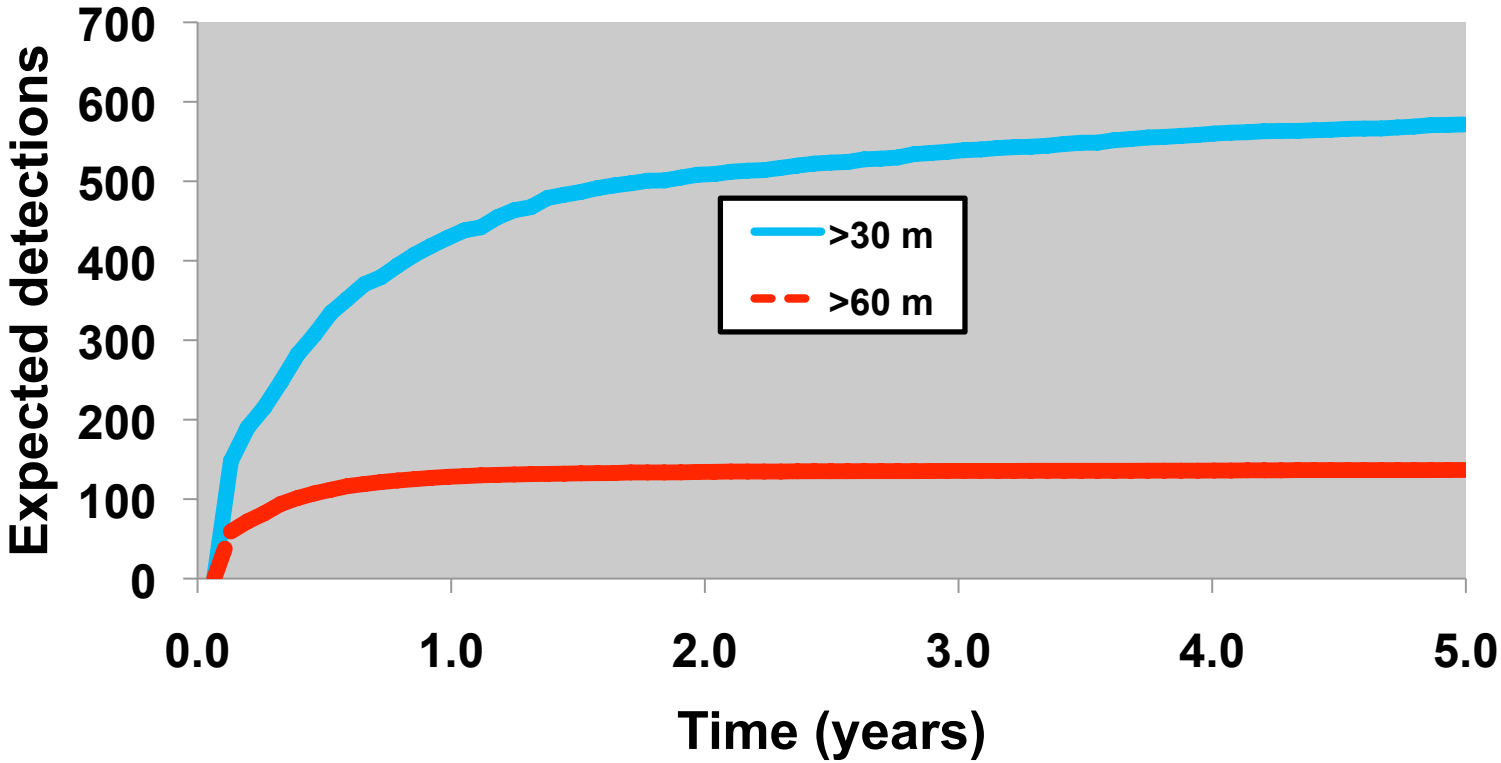
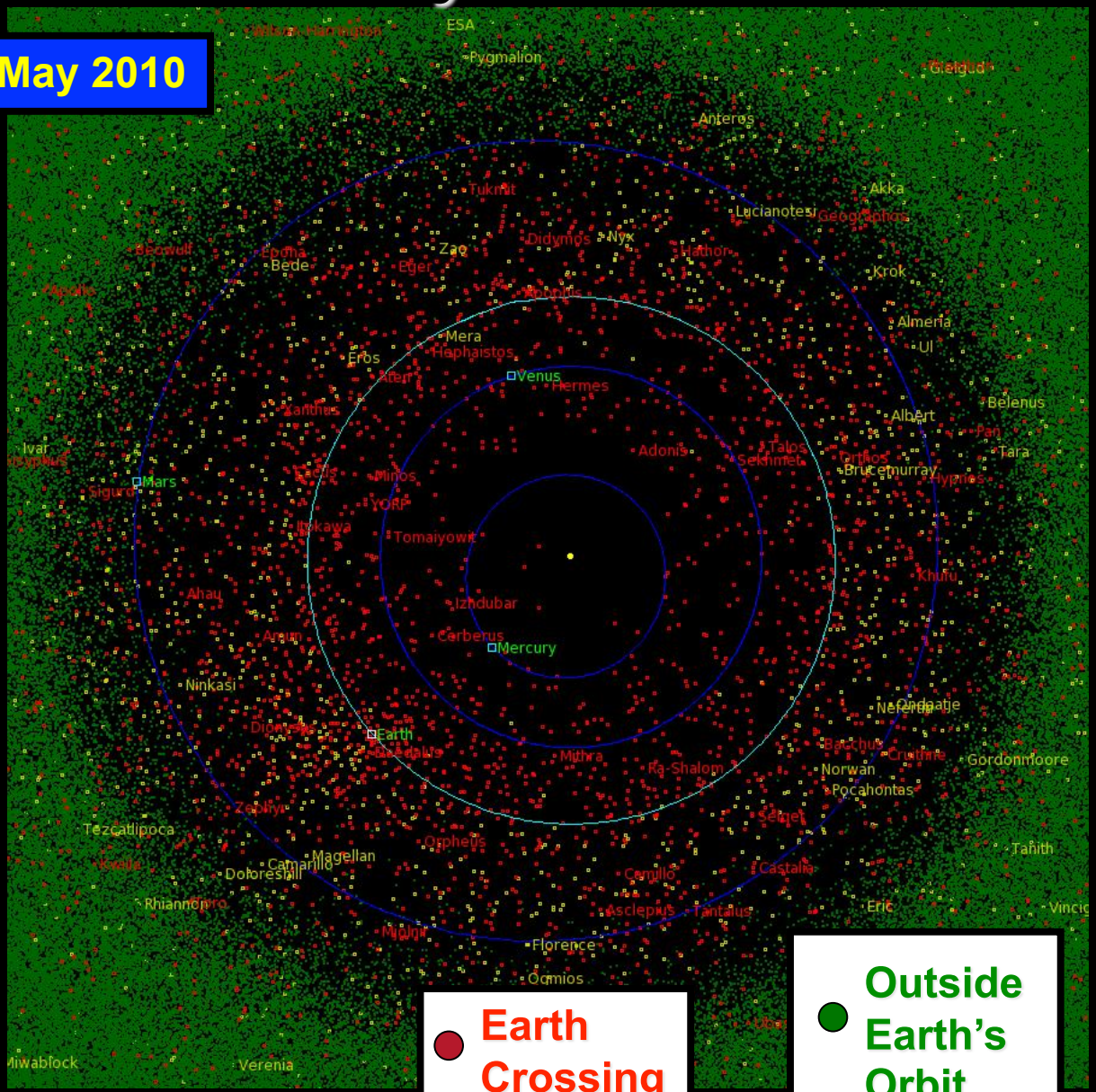
# Back Up

# Predicted dectections of Human Exploration targets with twin spacecraft in oppositely phased orbits




Expected number of detected NEOs when we have two IR telescopes in Venus-like orbit, with orbital phase 180° apart. This is for Human Exploration targets which can be reached with <5 km/s one-way delta-v (from Earth escape).

# Discovery Rate of the NEO Population




**20 April 2010**

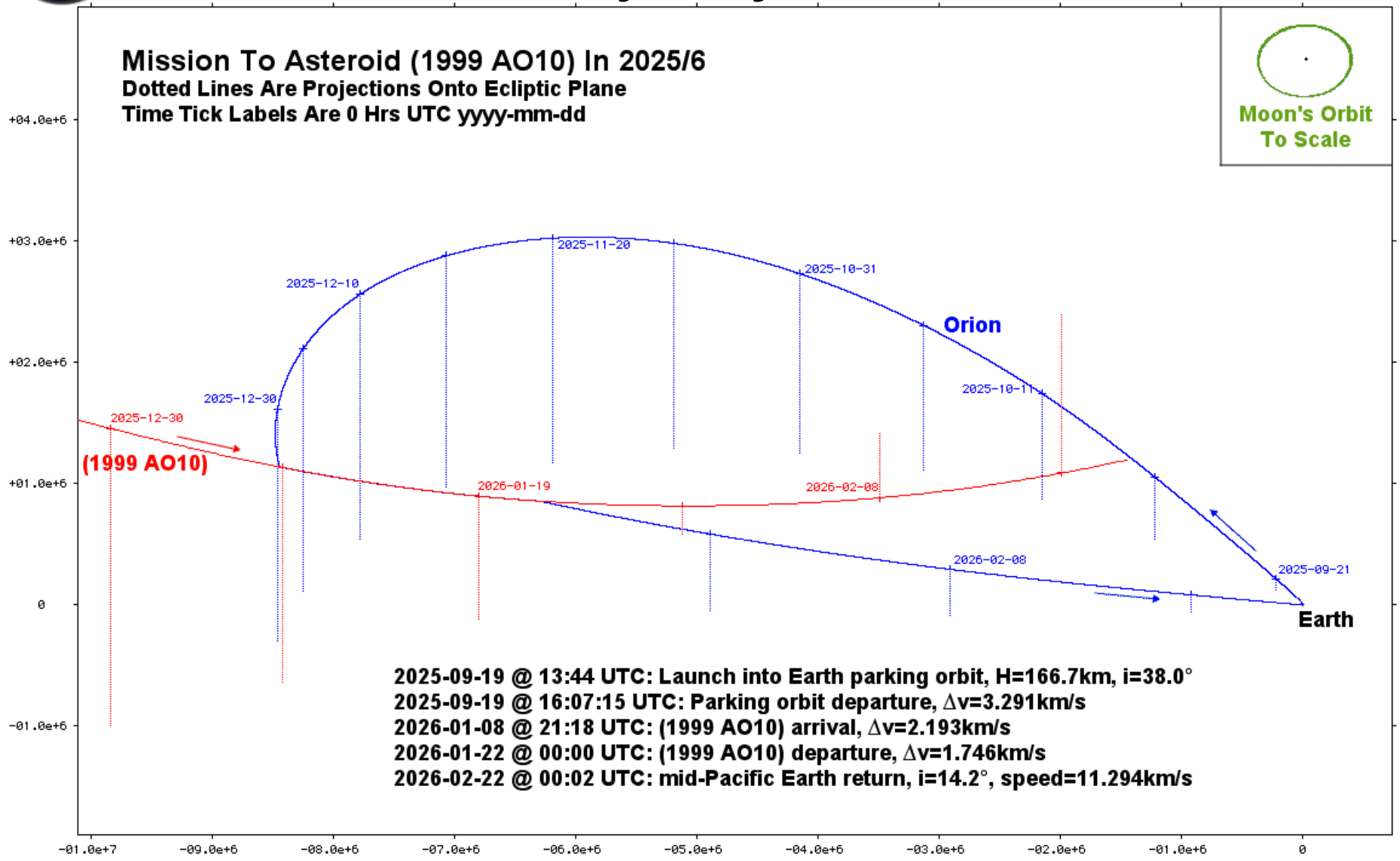
- ~500,000+ Minor Planets
- 6989 NEOs
- 1116 PHOs

**Improved NEO Survey Will Likely Find**

- 50,000+ NEOs (>140 meters)
- 10,000+ PHOs

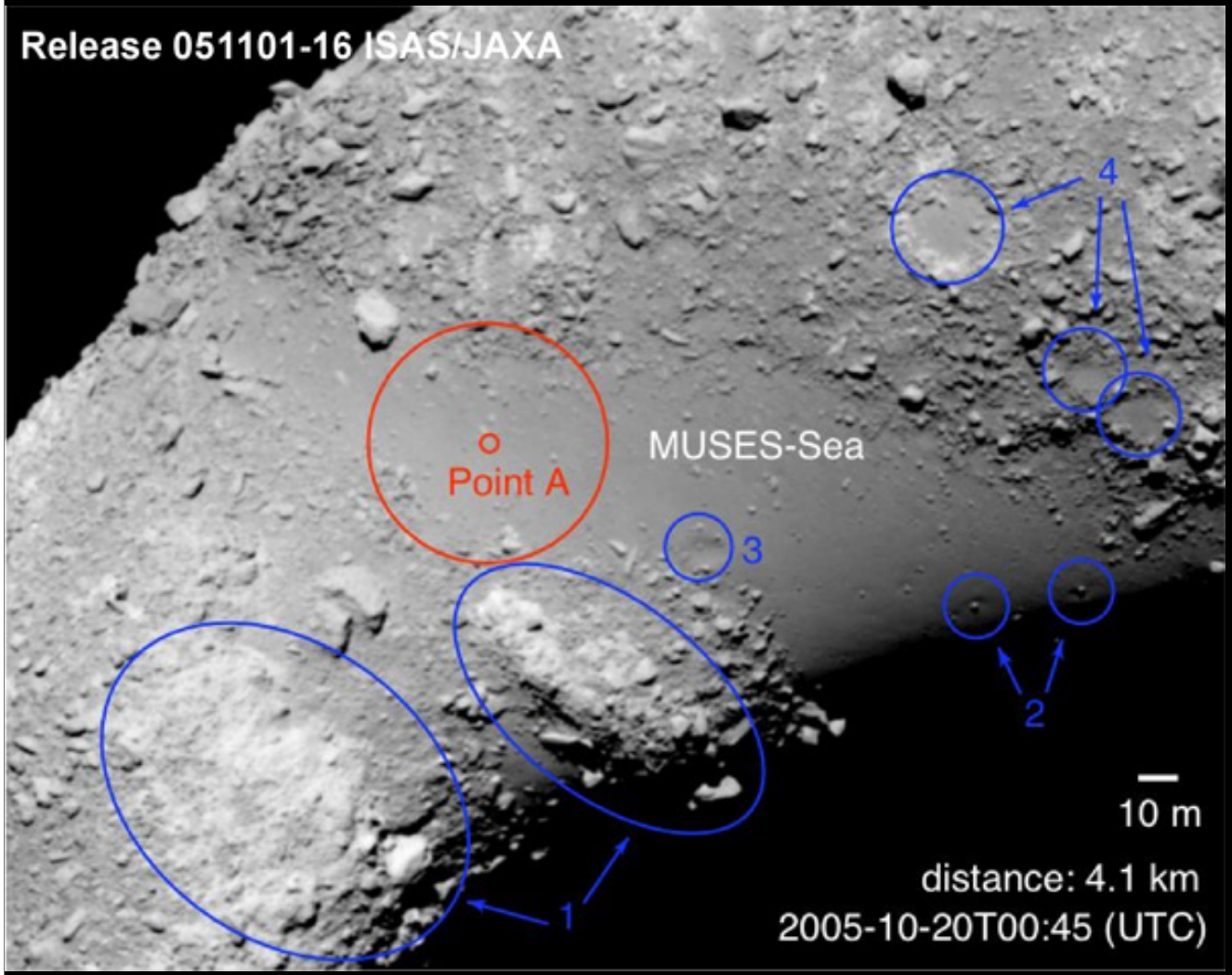
Images from: Scott Manley
Armagh Observatory

# 150-Day Mission to 1999 $AO_{10}$
# Earth-fixed Trajectory Plot for Mission




Km Units View From Y= 0.0°, P= 0.0°, R= 45.0°
Earth-Centered J2KE Coordinate System
Visit to (1999 A01O)

# *Hayabusa Touchdown Site Candidate A: Muses Sea*




**Largest smooth terrain located between the "Head" and "Body" of the Otter-like [shape of Itokawa]**

**~60 m across at its widest point.**

# *Hayabusa Touchdown Site Close-Up*


*h* = 80 m

*h* = 68 m

*h* = 63 m

**(Spatial Resolution: 6-8 mm/pixel)**